

ACETONE AND METHANE DETECTION WITH WAVELENGTH MODULATION SPECTROSCOPY IN THE NEAR- AND MID-IR

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A high sensitivity sensor, combining a multipass cell and wavelength modulation spectroscopy in the near-IR spectral region ($1.651\mu\text{m}$) was designed and implemented for trace gas detection. The sensor uses a DFB laser and software lock-in detection, realized with a LabVIEW code. The high sensitivity was achieved by combining the multipass cell having a long effective absorption length of 290 meters, the wavelength modulation spectroscopy, and noise suppression by using a dual beam scheme. The developed spectroscopic technique demonstrates an improved sensitivity for methane in ambient air and a relatively short detection time compared to previously reported sensors. The average methane concentration measured in ambient air was 2.01ppm with a relative error of $\pm 2.5\%$. With Allan deviation analysis, it was found that the methane detection limit of 1.2ppb was achieved in 650s. A modification of this scheme for acetone detection with a mid-IR distributed feedback interband cascade laser with the center wavelength around $3.367\mu\text{m}$ was also developed, achieving the detection limit was 0.58 ppm with 1s and down to 0.12 ppm with 60s signal averaging.

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